REMARKS/ARGUMENTS

Claims 4 and 6 are pending in this application.

Claims 4-6 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Kamiyama et al. (U.S. 6,043,940) in view of Gopalan et al. (U.S. 6,211,999). Applicant respectfully traverses the rejection of Claims 4 and 6.

Claim 4 recites:

> **A lens** comprising:
> lithium tantalate including a lithium oxide and a tantalum oxide; wherein
> **a molar composition ratio of the lithium oxide and the tantalum oxide (Li_2O/Ta_2O_5) in the lithium tantalate is in a range of 0.975 to 0.982**; and
> **a birefringence of the lithium tantalate is in a range of -0.0005 to 0.0005**.

As described in paragraphs [0006] to [0008] of Applicant's originally filed Substitute Specification, lithium tantalate is well-known as a material for optical elements, such as a wavelength conversion element, an optical diffraction element, and a phase conjugate mirror. However, lithium tantalate has not previously been used for a lens because of a relatively large birefringence based on the difference of the refractive indexes between an ordinary ray and an extraordinary ray.

However, the inventors of the present invention discovered that the birefringence is greatly reduced in lithium tantalate having the composition recited in Applicant's Claim 4, and that lithium tantalate having the particular composition recited in Applicant's Claim 4 can preferably be used as a lens, especially usable for natural light and light coming from various angles. Specifically, the lens recited in Applicant's Claim 4 comprises lithium tantalate having a molar composition ratio of lithium oxide and tantalum oxide (Li_2O/Ta_2O_5) in a range of 0.975 to 0.982. The birefringence can be confined within a range of ±0.0005 in lithium tantalate having this particular molar composition ratio, whereas with a well-known stoichiometric composition or a congruent composition as the molar composition ratio of the lithium tantalate, the birefringence cannot be confined within a range of ±0.0005 in lithium tantalate.

In this manner, a miniaturized and thin lens utilizing a high refractive index (i.e., more than 2.0) of the lithium tantalate can be provided (see for example, paragraphs [0006], [0054], [0055] of Applicant's originally filed Substitute Specification and Figs. 4 and 5 of Applicant's originally filed drawings).

Furthermore, the lens as recited in Applicant's Claim 4 can be used not only for laser light that can generate a mono-dispersed wavelength, but also for natural light and light coming from various angles because it is not necessary to control the angle between incoming light and the optical axis of the lithium tantalite in advance (see, for example, paragraphs [0024], [0069] of Applicant's originally filed Substitute Specification). Since confining angle between the incident direction of light and the optical axis is unnecessary with the lens recited in Applicant's Claim 4, an optical system can be freely designed with more flexible and at reduced costs.

The lens recited in Applicant's Claim 4 is capable of obtaining an increased effective diameter (NA) as compared to existing lenses, such as glass lenses, and thus, the brightness is increased (see, for example, paragraph [0058] and Table 1 of Applicant's originally filed Substitute Specification).

As a result, the effective aperture of the lens recited in Applicant's Claim 4 can be reduced as compared to existing lenses. Thereby, if the lens recited in Applicant's Claim 4 is used for optical electronic devices, such as an endoscope, a magneto optical disk, and a digital camera, the optical electronic devices can be miniaturized.

As shown from the relationship between the molar composition ratio and the refractive index in Fig. 2 of Applicant's originally filed drawings, the range of ±0.0005 of the birefringence can be achieved in lithium tantalate with a molar composition ratio that is deviated from the stoichiometric composition ((Li_2O/Ta_2O_5) =1.00).

The range of ±0.0005 of the birefringence in lithium tantalate can be achieved in a range of the molar composition ratio that is slightly shifted from the stoichiometric composition toward the Li deficient side. The range of ±0.0005 of the birefringence cannot be achieved with the well-known stoichiometric composition nor with the congruent composition as the molar composition ratio of the lithium tantalate.

The Examiner alleged Kamiyama et al. teaches an optical system for optical recording including a hemispheric lens of a single crystal having a refractive index, wherein the single crystal is lithium tantalate. The Examiner acknowledged that Kamiyama et al. fails to teach a molar composition ratio and a birefringence of the lithium tantalate single crystal. The Examiner further alleged that Gopalan et al. teaches a lithium tantalate single crystal having a molar fraction of ($Li_2O/(Li_2O+Ta_2O_5)$) between 0.492 and 0.50, and that when the molar fraction is converted into molar composition of (Ta_2O_5+ Li_2O), the range of $Li_2O+Ta_2O_5$ is between 0.967 and 1.00. Thus, the Examiner concluded that it would have been obvious "to incorporate Gopalan with Kamiyama because lithium tantalite single-crystal taught by Gopalan enables crystal perfectness and is useful in lens applications." Applicant disagrees.

Kamiyama et al. teaches that when a lithium tantalate single crystal is used for a lens, the effects of double refraction corresponding to birefringence should be minimized. In other words, Kamiyama et al. teaches that a direction of an incident ray must be confined within 0.1 degree from an optic axis of the lithium tantalate single crystal so as to minimize the effects of double refraction (see, for example, col. 6, lines 19 to 21 of Kamiyama et al.). Kamiyama et al. also discloses that converging the ray onto two points can be achieved through the effect of double refraction by modifying the direction of the incident ray appropriately in relation to the crystallographic optical axis in addition to the direction of the incident ray being aligned with the direction of the optical axis of the lithium tantalate single crystal (see, for example, col.6, lines 34 to 37 of Kamiyama et al.).

In view of the restrictions described above with respect to the direction of an incident ray with respect to the lens, Kamiyama et al. clearly acknowledges that the lithium tantalate single crystal disclosed therein cannot be used for the lens utilizing natural light and light coming from various angles. Because the lithium tantalate single crystal has a large birefringence based on the difference of the refractive indexes between an ordinary ray and an extraordinary ray, the degree between the direction of

the incident ray and the optical axis must necessarily be tightly confined in order for the lithium tantalate single crystal to be used as a lens.

Kamiyama et al. discloses that the refractive index for an ordinary ray (no) and the refractive index for an extraordinary ray (ne) of the lithium tantalate single crystal are 2.18 and 2.17 respectively (see, for example, col. 6, lines 38 to 40 of Kamiyama et al.), and the birefringence is 0.01. This birefringence is much larger than the birefringence (around 0.0005) of the known lithium tantalate described in Applicant's originally filed Substitute Specification, and thus, the lithium tantalate has not been used as a lens due to images being duplicated for natural light or light coming from various angles (see, for example, paragraph [0008] of Applicant's originally filed Substitute Specification). As disclosed in Fig. 2 of Applicant's originally filed specification, the lithium tantalate having a birefringence of 0.01, such that that disclosed in Kamiyama et al., has a congruent composition.

Therefore, although Kamiyama et al. discloses a lens that is made of a lithium tantalate single crystal, Kamiyama et al. only discloses a specific control method for the lens made of the lithium tantalate single crystal having a large birefringence, i.e., aligning the direction of the incident ray and the direction of the optic axis. Kamiyama et al. discovered such a control method because Kamiyama et al. acknowledged that a large birefringence of a lithium tantalate single crystal is an inherent characteristic of the material. However, Kamiyama et al. clearly fails to identify or address the problem of minimizing the birefringence of the lithium tantalate single crystal minimize to the greatest extent possible. Accordingly, Kamiyama et al. does not recognize the fact that the birefringence of the lithium tantalate single crystal may be changed by subtle composition changes of the lithium tantalate single crystal.

The Examiner alleged that Gopalan et al. teaches a lithium tantalate single crystal having a molar fraction of ($Li_2O/(Li_2O+Ta_2O_5)$) between 0.492 and 0.50 (equivalent to a molar composition ratio of (Li_2O/Ta_2O_5) between 0.967 and 1.00).

In addition, the Examiner alleged that the birefringence of the lithium tantalate single crystal disclosed in Gopalan et al. is substantially identical to the birefringence recited in Applicant's Claim 4 because the range of the molar composition ratio described in Gopalan et al. includes the molar composition ratio recited in Applicant's Claim 4 (see lines 6 to 8 on page 3 and lines 3 to 5 on page 4 of outstanding Office Action). Applicant respectfully and strenuously disagrees.

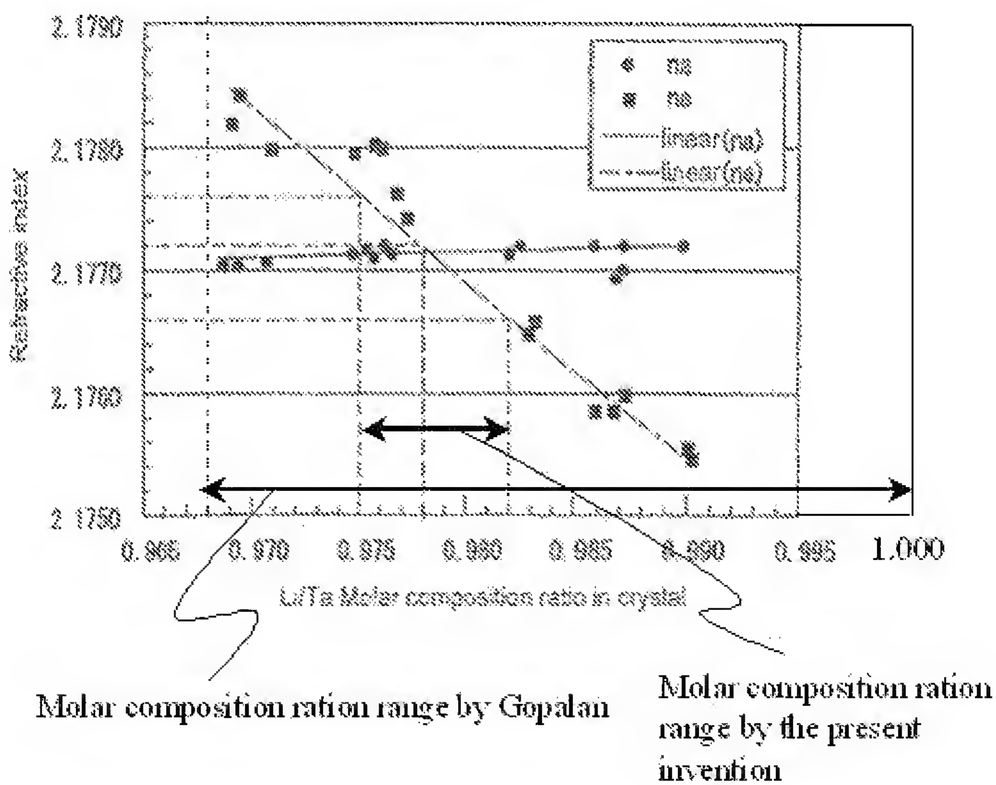
Applicant's Claim 4 recites a very specific and narrow range of molar composition ratios of 0.975 to 0.982 for the lithium tantalate single crystal. A birefringence of -0.0005 to +0.0005 of the lithium tantalate is only obtained when the molar composition ratio of the lithium oxide and the tantalum oxide (Li_2O/Ta_2O_5) in the lithium tantalate is in a range of 0.975 to 0.982. The vast majority of the values of the molar composition ratios of 0.967 to 1.00 disclosed in Gopalan et al. falls outside of the range of 0.975 to 0.982 recited in Applicant's Claim 4. As such, the birefringence of the vast majority of the lithium tantalate single crystals disclosed in Gopalan et al. is outside of the range of -0.0005 to +0.0005 recited in Applicant's Claim 4.

More particularly, Gopalan et al. discloses a range of 0.033 (1.00 - 0.967) for the molar composition ratios, whereas Applicant's Claim 4 recites a range of 0.007 (0.982 - 0.975) for the molar composition ratios. Thus, only 21.21% (0.007/0.033) of the molar composition ratio values disclosed in Gopalan et al. fall within the range of molar composition ratios recited in Applicant's Claim 4. Thus, contrary to the Examiner's allegations, Gopalan et al. certainly cannot possibly be fairly construed as teaching or suggesting, either inherently or explicitly, a birefringence of the lithium tantalate single crystal disclosed in Gopalan et al. that is substantially identical to the birefringence recited in Applicant's Claim 4, because over 78% of the molar composition ratio values disclosed in Gopalan et al. produce a birefringence that is outside of the range of -0.0005 to +0.0005 as recited in Applicant's Claim 4.

Gopalan et al. does not teach, suggest, or even recognize that only lithium tantalate having a molar composition ratio of (Li_2O/Ta_2O_5) between 0.975 and 0.982 as

recited in Applicant's Claim 4 (among the molar composition ratio of (Li_2O/Ta_2O_5) between 0.967 and 1.00 disclosed in Gopalan et al.) has a birefringence within ±0.0005.

Although Gopalan et al. teaches a lithium tantalate single crystal with the molar composition ratio that includes a molar composition ratio that falls within the range recited in Applicant's Claim 4, Gopalan et al. fails to teach, suggest, or even recognize an relationship whatsoever between the molar composition ratio and the birefringence of lithium tantalate. As shown in the following figure (which substantially corresponds to Fig. 2 of Applicant's originally filed drawings), it is clear that the lithium tantalate single crystal of Gopalan et al. includes molar composition ratio values which are not suitable for use in a lens due to the large amount of birefringence.



Thus, contrary to the Examiner's allegations, Gopalan et al. fails to teach or suggest the features of "a molar composition ratio of the lithium oxide and the tantalum oxide (Li_2O/Ta_2O_5) in the lithium tantalate is in a range of 0.975 to 0.982" and "a

birefringence of the lithium tantalate is in a range of -0.0005 to 0.0005" as recited in Applicant's Claim 4.

Therefore, even assuming *arguendo* that there would have been some technical reason to combine the alleged teachings of Gopalan et al. with Kamiyama et al., the resulting combination would still clearly fail to teach or suggest the features recited in Applicant's Claim 4, including the features of "a molar composition ratio of the lithium oxide and the tantalum oxide (Li_2O/Ta_2O_5) in the lithium tantalate is in a range of 0.975 to 0.982" and "a birefringence of the lithium tantalate is in a range of -0.0005 to 0.0005."

The Examiner is reminded that inherency may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient. *In re Oelrich*, 666 F.2d 578, 581 (CCPA 1981). *See also Ex parte Skinner*, 2 USPQ2d 1788, 1789 (BPAI 1986) ("[T]he examiner must provide some evidence or scientific reasoning to establish the reasonableness of the examiner's belief that the functional limitation is an inherent characteristic of the prior art" before the burden is shifted to the applicant to disprove the inherency.).

The following Table provides a comparison of the alleged teachings of Kamiyama et al. and Gopalan et al.

Applicant's Invention		Kamiyama et al.	Gopalan et al.
Claim 4	Lens comprising lithium tantalate	○	×
	Molar composition ratio (Li_2O/Ta_2O_5)=0.975 - 0.982	×	○ (No specific description)
	Birefringence= -0.0005 to +0.0005	×(Birefringence=0.01)	×
Task	To reduce birefringence of lithium tantalate	×	×
Effect	Natural light or light comes in from various angle are usable	×(Natural light or light comes in from various angle are not usable)	×
	Increasing the flexibility of the formulation of optical system	×(necessary controlling degree between incoming light and the optic axis)	×

○: disclose
×: not disclose

As noted above, Kamiyama et al. acknowledged the fact that the lithium tantalate single crystal has a large birefringence as an inherent characteristic of the material and fails to teach or suggest any relationship between the molar composition ratio and the birefringence. Therefore, even if Kamiyama et al. used the lithium tantalate single crystal described in Gopalan et al., it would not lead to the selection of appropriate molar composition ratios to minimize the birefringence of lithium tantalate single crystal.

The Examiner alleged that the reason to combine the alleged teachings of Gopalan et al. with Kamiyama et al. would have been to enable high crystal perfectness. However, neither Gopalan et al. nor Kamiyama et al. teaches or suggests anything at all about high crystal perfectness being beneficial or desirable in a lens, such as the lens taught by Kamiyama et al.

In addition, the Examiner has failed to explain why it would have been desirable in the lens of Kamiyama et al. to have high crystal perfectness as allegedly taught by Gopalan et al. Instead, the Examiner has merely made a conclusory statement that the combination of Gopalan et al. and Kamiyama et al. would enable high crystal perfectness. "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." (*In re Kahn*, 441 F. 3d 977, 988 (CA Fed. 2006) cited with approval in KSR)

Further, the Examiner alleged that Gopalan et al. discloses the photo functional element including the lithium tantalate single crystal and the photo functional element is a lens or optical electronic device. However, the photo functional element disclosed in Gopalan et al. is the photo functional element using the superior electro-optical constant and the nonlinear optical constant of the lithium tantalate single crystal, and more specifically, second harmonics generation (SHG) elements, optical parametric oscillation (OPO) elements and memory elements. The photo functional element disclosed in Gopalan et al. is completely different from the lens recited in Applicant's Claim 4 and the lens disclosed in Kamiyama et al., and Gopalan et al. fails to teach or suggest that the lithium tantalate single crystal disclosed therein could or should be

used as a lens. Thus, one of ordinary skill in the art would not have looked to Gopalan et al. to allegedly cure a deficiency of Kamiyama et al.

The Examiner further alleged that Applicant's allegation that Gopalan et al. fails to teach the relationship between the molar composition ratio and the birefringence of lithium tantalate is not accepted because its relationship is inherent. However, as described above regarding Kamiyama et al., a large birefringence was considered to be an inherent characteristic of lithium tantalate single crystals, and, at the time Applicant's claimed invention was made, it was not known that a birefringence of lithium tantalate fluctuated with changes of a molar composition ratio.

The inventors of the present invention discovered, for the first time, that the molar composition ratio of lithium tantalate and the birefringence of lithium tantalate are related to one another, and that the birefringence of lithium tantalate could be maintained in the range of -0.0005 to +0.0005 by restricting the molar composition ratio of the lithium oxide and the tantalum oxide (Li_2O/Ta_2O_5) in the lithium tantalate to a range of 0.975 to 0.982.

Thus, prior to Applicant's claimed present invention, one of ordinary skill in the art would not have recognized that any relationship whatsoever exists between the molar composition ratio of lithium tantalate and the birefringence of lithium tantalate, and would not have realized that the birefringence of lithium tantalate could be changed or controlled by changing the molar composition ratio of the lithium tantalate.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 4 under 35 U.S.C. § 103(a) as being unpatentable over Kamiyama et al. in view of Gopalan et al.

In view of the foregoing remarks, Applicant respectfully submits that Claim 4 is allowable. Claim 6 depends upon Claim 4, and is therefore allowable for at least the reasons that Claim 4 is allowable.

In view of the foregoing remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are solicited.

The Commissioner is authorized to charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-1353.

Respectfully submitted,

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